COURSE XIV

Booklovers Reading Clu

Hand-Book

STUDIES IN APPLIED ELECTRICITY

Mr. Thomas A. Edison

Dr. Elihu Thomson

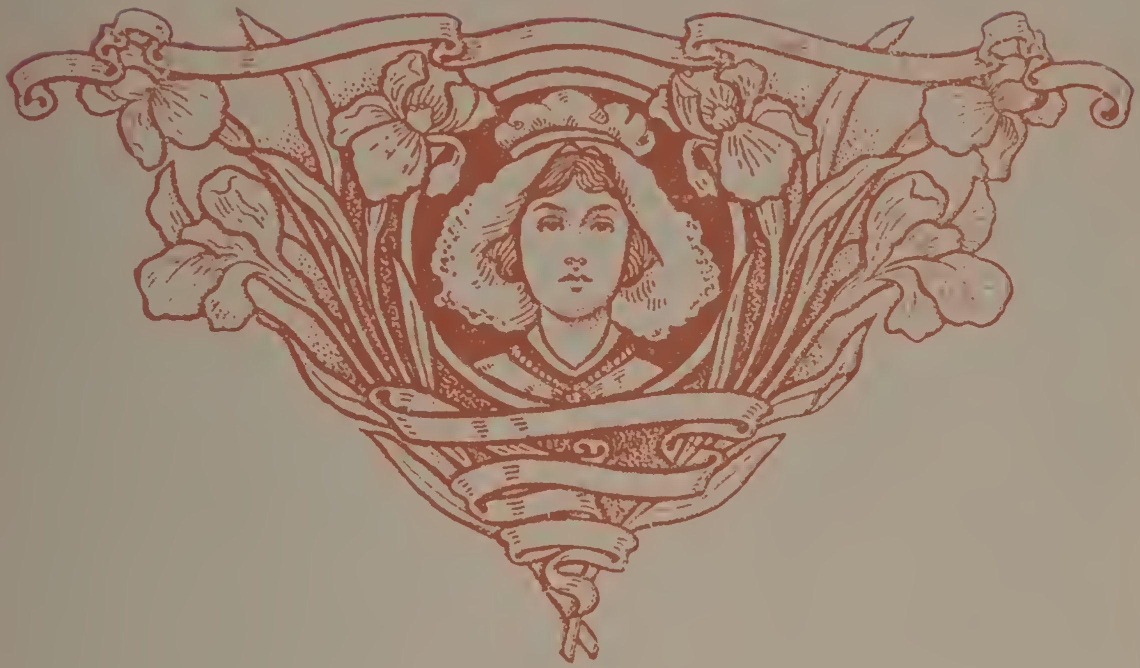
Dr. Edwin J. Houston

Mr. Carl Hering

Mr. Arthur V. Abbott

And Othe

The Booklovers Library



ISSUED FROM THE PRESS OF
THE *BOOKLOVERS* LIBRARY
1323 WALNUT ST., PHILADELPHIA

THE BOOKLOVERS READING CLUB HAND-BOOK TO ACCOMPANY THE READING COURSE ENTITLED, *STUDIES IN APPLIED ELECTRICITY*

SEYMOUR EATON
Librarian

FREDERIC W. SPEIRS, Ph.D.
Educational Director

STUDIES IN APPLIED
ELECTRICITY

Course *XIV:* Booklovers Reading Club

BOOKS SELECTED

FOR THIS READING COURSE

by

MR. THOMAS A. EDISON

and

DR. EDWIN J. HOUSTON

The BOOKS

*T*HE *following three books are supplied by The Booklovers Library to Club Members who have enrolled for Course* XIV.

I. ELEMENTARY LESSONS IN ELECTRICITY *AND* MAGNETISM

(Silvanus P. Thompson)

II. *THE* ELECTRIC CURRENT

(R. Mullineux Walmsley)

III. ELECTRICAL ENGINEERING LEAFLETS: ELEMENTARY GRADE

(E. J. Houston, Ph.D.,)
and
(A. E. Kennelly, F.R.A.S.)

The course of reading as outlined in this hand-book is based on these books. Supplementary lists of books recommended by MR. EDISON *and* DR. HOUSTON *will be found at the end.*

STUDIES IN APPLIED ELECTRICITY

TALKS *to* STUDENTS

by

Dr. ELIHU THOMSON

and

Dr. EDWIN J. HOUSTON

and

Mr. CARL HERING

and

Mr. ARTHUR V. ABBOTT

These papers by Dr. Thomson, Dr. Houston, Mr. Hering and Mr. Abbott have been prepared especially for readers of this course.

OUTLINES AND QUESTIONS

by

Dr. GEORGE F. STRADLING

A WORD *from* THE DIRECTOR

A COMPLETE working knowledge of a technical subject cannot be gained by reading books. Actual contact with the working appliances of the laboratory and the shop is essential. We are fully aware of this fact in presenting this course in electricity to our readers. Its purpose is simply to lay a foundation which may serve as a basis for the practical knowledge of electricity that comes through the use of apparatus.

In inviting Mr. Edison and Dr. Houston to

recommend a course of reading, we acted on the assumption that our readers were entitled to the most expert judgment available for the choice of books upon this subject. The student will feel entirely safe in investing his time in books recommended by these authorities.

In our invitation to the contributors of papers, we requested that the writers should give stimulus and guidance to readers who were approaching the subject for the first time. Having a practical end in view, we invited eminent engineers, not theoretical electricians, to prepare the papers. Our readers thus have the benefit of the suggestions of a notable group of men. Dr. Elihu Thomson has an international reputation as an electrical engineer. Dr. Houston has attained eminence in his profession through his important inventions and his numerous books. Mr. Carl Hering, ex-President of the Institute of Electrical Engineers, and Mr. Arthur V. Abbott, of the Chicago Telephone Company, are consulting engineers of wide experience and high authority.

The very comprehensive series of questions and the full suggestions for supplementary reading prepared by Dr. George F. Stradling are especially valuable to the reader who desires to dig deep. Dr. Stradling has been careful to indicate

books and articles which may be read with profit by those who have little technical knowledge and only slight acquaintance with mathematics.

Equipped with the books approved by Mr. Edison and Dr. Houston, and guided by the suggestions of working engineers who stand at the head of their profession, the reader should find the course highly profitable.

The Idea of the Course

THIS course was designed with two distinct purposes in mind. In the first place, we planned to give the general reader who has a scientific turn of mind an insight into the action of electrical forces which will enable him to understand the principles of the telephone, the electric light, the street-car motor and other common electrical appliances. Electricity is playing such an important part in modern life that many intelligent persons who have no distinct technical purpose in mind wish to learn something about its practical applications.

In the second place we had in view the needs of the student who desires to begin a course of reading which will prepare him for further study with the ultimate purpose of becoming an electrical engineer. For the benefit of such students the editor has divided the course into topics, and has furnished very complete sets of questions and carefully selected references for supplementary reading. The student who reads the course thoroughly, using all the aids so liberally supplied, will not be qualified to design a dynamo, but he will have an excellent start on the road toward his professional goal.

PRINCIPAL TOPICS *OF THE COURSE*

I. General Ideas of Electric Currents and Circuits.

II. Electric Quantities and Units.

III. Ohm's Law.

IV. Electrical Instruments.

V. The Heat Developed by the Electric Current.

VI. Electric Incandescent Lighting.

VII. Electric Arc Lighting.

VIII. Magnetism.

IX. The Magnetism of the Earth.

X. The Electromagnet.

XI. The Telegraph.

XII. The Voltaic Cell.

XIII. The Chemical Effects of the Current.

XIV. The Storage Cell.

XV. The Production of Currents by Induction.

XVI. The Telephone.

XVII. The Continuous Current Dynamo.

XVIII. The Continuous Current Motor.

XIX. Alternating Currents.

XX. The Alternator.

XXI. The Alternating Current Motor.

XXII. The Alternating Current Transformer.

XXIII. The Electric Transmission of Power.

XXIV. The Electric Railway.

XXV. Wireless Telegraphy.

HINTS AND SUGGESTIONS TO THE READER

The references to the books supplied are arranged under each topic in the order in which they should be read.

If the reader is specially interested in any one topic he will find the following order of reading helpful in arriving most directly at the particular subject which he wants. The topics are here arranged in such order that the reading leads up to the subject coming last in the series. For example, if the reader wishes to understand the telephone (topic XVI), he should first master the electromagnet (topic X), and then pass to the production of currents by induction (topic XV). He may then read with advantage the references on the telephone (topic XVI).

[V, VI.] [V, VII.] [X, XI.] [XII, XIII, XIV.] [X, XV.] [X, XV, XVI.] [X, XV, XVII.] [X, XV, XVII, XVIII.] [X, XV, XVII, XIX, XX.] [X, XV, XVII, XIX, XX, XXI.] [X, XV, XIX, XXII.] [XVII, XVIII, XIX, XX, XXI, XXII, XXIII.] [XVII, XVIII, XXIV.]

It is recommended that the reader, in every case, first make himself acquainted with topics I, II, III and VIII. Any of the topics IV, V, IX, XII, XIII and XIX may then be read.

If the reader can follow the mathematical reasoning, it is best to do it. Next to this in advantage is a careful examination of the formula embodying the result of the reasoning. The meaning of each letter should be found, and, if it is possible, the formula applied to the solution of a simple problem. The main facts, however, stand out clearly without the aid of mathematics.

Attention is directed to the fact that each of the three books in the course is provided with a good index.

There is no better way of keeping in touch with the modern applications of electricity than by reading regularly some good electrical journal, such as *The Electrical World and Engineer*, a weekly publication, or *The American Electrician*, a monthly journal. It is surprising how much benefit is derived in this way, and at how small an expenditure of time and money.

Not all the questions, given in the topical outline which follows, can be answered by reference to the books of the course. It is hoped that the reader will think them over carefully after he

has gone over the readings under the topic, and, if he is unable to answer them, will turn to some of the supplementary readings for assistance. A considerable body of questions appears at the end of *Elementary Lessons in Electricity and Magnetism*.

The visiting of power plants and factories where electricity is employed is of much value, and the student should seek opportunity to experiment with apparatus.

The COURSE ARRANGED *by* TOPICS

The names Houston and Kennelly, Thompson, Walmsley, *printed in italics immediately following the topics of this outline, refer to the books of these respective authors which are furnished with this course.*

I. GENERAL IDEAS OF ELECTRIC CURRENTS AND CIRCUITS.

Houston and Kennelly, Leaflet 1, Section 56 and Leaflet 8.
Thompson, Section 167.
Walmsley, Chapter II.

QUESTIONS

1. What effects does a current produce in the material through which it flows?

2. What methods are there of producing a current?

3. What is the difference between joining in series and in multiple?

4. Study the Law of the Conservation of Energy.

5. What are the different parts of the electric circuit used in ringing a bell?

6. What is the difference between a direct or continuous current and an alternating current?

7. A wire passes through a room. Without cutting it, how can you find whether a direct current is flowing through it? An alternating current?

8. Where is there an error in the expression "a generator of electricity?"

9. What reason is there for thinking that anything moves when a current flows?

10. What application of the electric current has, in your opinion, produced the greatest change in modern life?

SUPPLEMENTARY READING

Books.

What is Electricity? J. Trowbridge.
Chapter IV. The Electric Current.
Chapter IX. Sources of Electric Power.
Practical Electricity. W. E. Ayrton.
Chapter I. The Electric Current and Its Measurement.
Electrical Lighting. F. B. Crocker. Vol. I.
Chapter VII. Possible Sources of Electrical Energy.

Periodicals.

Electrical World and Engineer. Vol. 37, p. 20 (Jan. 5, 1901).
Electricity in the Coming Century. Elihu Thomson.
Vol. 37, p. 22. Electrical Energy Direct from Coal. A. E. Kennelly.

II. ELECTRIC QUANTITIES AND UNITS

Houston and Kennelly, Leaflets 2, 3, 4, 5 and 6.
Thompson, Sections 169, 171, 190, 400–405, 408, 435–437, Lesson XXVII, Sections 280–283 and Appendix B, p. 586.
Walmsley, Pages 37, 38, 271–278, 283–289, 305, 372, 387, 407–409, 411–414.

QUESTIONS

1. What electrical units are named after Germans? After Britons, Frenchmen, Italians, Americans?

2. Why are all electrical units based upon the metric system?

3. Define the practical unit of E. M. F.

4. To what in the flow of water is E. M. F. analogous?

5. What are the sources of the E. M. F?

6. Can an E. M. F. exist without producing a current?

7. What is an ampere? A coulomb? An ohm?

8. What effect does change of temperature have upon electrical resistance?

9. Why are resistance coils generally made of alloys?

10. What is the distinction between a joule and a watt?

SUPPLEMENTARY READING

Books.

Electric Lighting. F. B. Crocker.
Vol. 1, chapter III. General Units and Measures.
Short Lectures to Electric Artisans. J. A. Fleming.
Lecture V.
Practical Electricity. W. E. Ayrton.
Chapters I–V.
Popular Lectures and Addresses. Sir William Thomson (Lord Kelvin), vol. I, p. 80. Electrical Units of Measurement.

Periodicals.

Science. Vol. 1, p. 9 (Jan. 4, 1895). T. C. Mendenhall. Legal Units of Electric Measure.
The Electrical Review. London, vol. 41, p. 656 (Nov. 12, 1897). A. Gray. Absolute Measurements.

III. OHM'S LAW

Houston and Kennelly, Leaflet 7, Sections 271 and 273.
Thompson, Sections 191, 399, 406.
Walmsley, Page 270.

QUESTIONS

1. Who was Ohm?

2. Why is Ohm's Law so important?

3. To what kind of currents does it apply?

4. If two binding posts whose difference of potential is 110 volts are joined by a coil whose resistance is 23 ohms, how much current flows?

5. How much is the resistance of an incandescent lamp when .54 ampere flows through it, the difference of potential at its terminals being 110 volts?

6. How many volts are required to send a current of 9.2 amperes through a resistance of 4 ohms?

7. While a cell is sending current through a circuit, a voltmeter shows that the difference of potential between its terminals is .6 volt. If the internal resistance of the cell is .3 ohm, is it right to conclude that the current through the cell is $\frac{.6}{.3}=2$ amperes?

8. It is desired to find the length of wire in a coil without unwinding it. The current and the difference of potential between the ends of the coil are measured. What else must be known in order to calculate the length of the wire?

9. A cell of E. M. F. 1.4 volts and internal resistance .6 ohm is joined to a circuit of resistance 7 ohms. How much current flows?

10. How much is the difference of potential between the ends of this circuit?

IV. ELECTRICAL INSTRUMENTS

Houston and Kennelly, Sections 36–38, 57, 138.
Thompson, Lesson XVII, Sections 290, 394–396, 412–415, 442.
Walmsley, Pages 277–282, 329–424.

QUESTIONS

1. Describe an arrangement by which the quantity of electricity which passes through in a given time is measured.

2. What instruments depend for their operation upon the magnetic effects of the current?

3. What is the difference between the way in which voltmeters aud ammeters are joined to a circuit?

4. Go to a switchboard and notice what instruments are mounted upon it.

5. Find how Weston instruments are constructed.

6. Why is it that a Cardew voltmeter answers both for continuous and for alternating currents?

7. What kind of a voltmeter takes no current?

8. How is the Wheatstone Bridge used?

9. Make a diagram of a plug resistance box.

10. Of what advantage are recording instruments?

SUPPLEMENTARY READING

Books.

Short Lectures to Electric Artisans. J. A. Fleming.
Lectures VI and VII.

Practical Electricity. W. E. Ayrton.
Chapters I and II. Weston instruments are described, pp. 145, 183.

Electric Lighting. F. B. Crocker.
Vol. 1, chapter XXIII. Electrical Measuring Instruments.
Vol. 2, chapter XIX. Meters.

What is Electricity? J. Trowbridge.
Chapter VII. The Galvanometer.

Periodicals.

The Electrical Review. London, vol. 41, p. 634 (Nov. 12, 1897).
W. A. Price. Electrical Instrument Making during the Period 1872–1897.

V. THE HEAT DEVELOPED BY THE ELECTRIC CURRENT

Houston and Kennelly, Leaflet 25.
Thompson, Lesson XXXVI.
Walmsley, Pages 311-314, 534-536, 552-560.

QUESTIONS

1. As the passage of an electric current through a wire constantly develops heat, why does the wire not continue to rise in temperature as long as the current flows?

2. What do you regard as the five most important applications of the heating effect of the current?

3. Why is the use of the current for heating purposes not more general?

4. Is heat produced when the current traverses electrolytes?

5. Describe the process of electric welding.

6. Find how carborundum, calcium carbide and artificial graphite are made.

7. Frozen water pipes have been thawed by the current. How would you make connections to do this?

8. Mention some advantages which the production of heat by the current has over its production by combustion.

9 How much heat is produced in half an hour by 7 amperes flowing through a resistance of 12 ohms?

10. Is there more heat developed per sec. by 5 amperes flowing through 2 ohms resistance or by 2 amperes flowing through 5 ohms?

SUPPLEMENTARY READING

Book.

Electric Heating. Houston and Kennelly.

Periodicals.

Electrical World. Vol. 30, p. 122 (July 31, 1897). J. P. Jackson. The Economy and Utility of Electrical Cooking Apparatus.

Electrical World and Engineer. Vol. 34, p. 337 (Sept. 2, 1899). A 250-h.p. Electric Heating Plant.

American Electrician. Vol. 9, p. 347 (Sept., 1897). The Economy and Utility of Electrical Cooking Apparatus.

Vol. 12, p. 501 (Oct., 1900). On Fuses.

Cassier's Magazine. Vol. 9, p. 522 (April, 1896). J. Sachs. Electric Metal Heating and Working.

Vol. 7, p. 418 (March, 1895.) N. W. Perry. Electric Cooking and Heating.

Western Electrician. Vol. 25, p. 60 (July 29, 1899.) Electric Heating and Cooking at the Carmelite Hospice.

Proceedings of the Royal Institution. Vol. 13, p. 185 (April, 1890). Sir F. Bramwell. Welding by Electricity.

VI. ELECTRIC INCANDESCENT LIGHTING

Houston and Kennelly, Leaflets 26, 27, Sections 65, 66, 77, 80.

Thompson, Sections 452, 453.

Walmsley, Pages 486–499, 518–552, 658–663.

QUESTIONS

1. Why is the air exhausted from the lamp bulb?

2. Why is platinum used to lead the current through the glass?

3. What is meant by saying that a lamp is 16 c. p.?

4. Make a diagram showing how incandescent lamps are joined to each other and to the dynamo or transformer for interior lighting.

5. Describe the manufacture of a filament.

6. In what manner does the candle-power of a lamp change with time?

7. Remove a lamp from its socket and notice how replacing it connects the two ends of the filament to the two wires ending in the socket.

Do not take the socket apart while the current is on.

8. Give some of the advantages which the incandescent lamp has over oil and gas.

9. Why is a carbon filament used?

10. About how many watts should be required for a 16 c. p. lamp? This is how many amperes, when the potential difference at the lamp terminals is 110 volts?

SUPPLEMENTARY READING

Books.

Electric Incandescent Lighting. Houston and Kennelly.
The Incandescent Lamp and Its Manufacture. G. S. Ram.
Electric Lighting. 2 vols. F. B. Crocker. This is a very complete treatise on lighting both by arc and by incandescent lamps.
A Century of Electricity. T. C. Mendenhall. Chapter VII. The Electric Light.

Periodicals.

Electrical World and Engineer. Vol. 37, p. 239 (Feb. 9, 1901). L. Bell. Electrical Illumination at the Beginning of the Twentieth Century.
American Electrician. Vol. 13, pp. 194 and 241 (April and May, 1901).
Cassier's Magazine. Vol. 16, p. 42 (May, 1899). A. D. Adams. Selection of Incandescent Lamps.
The Electrical Review, London. Vol. 41, p. 626 (Nov. 12, 1897). J. W. Swan. Twenty-five Years' Progress in Incandescent Lighting.
Journal of the Franklin Institute. Vol. 149, pp. 282, 353 and 419 (April, May and June, 1900).

VII. ELECTRIC ARC LIGHTING

Houston and Kennelly, Leaflets 28, 29, Sections 67, 75 and 79.
Thompson, Sections 448–451.
Walmsley, Pages 499–523.

QUESTIONS

1. Give two ways of telling which is the positive carbon in a continuous current arc lamp.

2. Why is the positive carbon in such a lamp placed above the negative one?

3. Examine a commercial arc lamp, and find out the purpose of each part. Be sure that the lamp is disconnected from the circuit.

4. What kind of an arc lamp needs to have the carbons renewed only after burning several nights?

5. Find out about alternating current arc lamps.

6. How are arc lamps usually joined to each other and to the dynamo?

7. In what respects does an enclosed differ from an open arc lamp?

8. Compare the number of volts required for direct current and for alternating current arc lamps.

9. Which must be the longer in a direct current arc lamp, the positive or the negative carbon? Why?

10. Under what conditions is it possible for a man standing on the ground to get a dangerous shock by touching one terminal of an arc lamp?

SUPPLEMENTARY READING

Books.

Electric Arc Lighting. Houston and Kennelly.
Electric Lighting. F. B. Crocker. 2 vols.

Periodicals.

Electrical World and Engineer. Vol. 37, pp. 271, 401, 475, 553, 601, 719 (1901). L. Bell. On Street Lighting by Arcs.

Vol. 37, p. 929 (June 1, 1901). Arc Lighting at the Beginning of the Twentieth Century.

American Electrician. Vol. 10, p. 11 (Jan., 1898). W. H. Freedman. The Enclosed Arc Lamp.

Vol. 12, p. 79 (Feb., 1900). R. Fleming. Alternating-Current Arc Lighting.

Vol. 12, p. 274 (June, 1900). H. H. Wait. A Comparison of Open and Enclosed Arc Lamps for Street Lighting.

Vol. 12, p. 327 (July, 1900). W. M. Stine. The Choice of Arc Lamps.

Vol. 12, p. 379 (Aug., 1900). A. L. Rice. Street Lighting by Series Alternating-Current Arc Lamps.

Vol. 13, p. 326 (July, 1901). Arc Lighting at the Beginning of the Twentieth Century.

The Electrical Review. London. Vol. 41, p. 654 (Nov. 12, 1897). R. E. Crompton. Twenty-five Years' Progress in Arc Lighting.

Transactions of the American Institute of Electrical Engineers. Vol. 14, pp. 361 and 471 (July, 1897). Freedman, Burroughs and Rapaport. The Enclosed Arc Lamp.

Vol. 16, p. 557 (Sept., 1899). W. L. Robb. Series Arc Lighting from Constant Current Transformers.

VIII. MAGNETISM

Thompson, Lessons VIII, IX, X and XI.
Walmsley, Pages 90–120.

QUESTIONS

1. Before it was known that magnets could be made by using the electric current, how were they procurable?

2. What reason is there for believing that the molecules of a magnet are themselves magnets?

3. What metals can be magnetized?

4. Given a compass. How can you find which the north-seeking pole of a magnet is?

5. What is Ewing's theory of magnetism?

6. Which gives the more definite information, magnetic attraction or repulsion?

7. By what means may the strength of a magnet be diminished?

8. Obtain the lines of force about a magnet by using iron filings.

9. What is the difference between the magnetic comportment of iron and that of steel?

10. What are the uses of permanent magnets?

SUPPLEMENTARY READING

Books.

Magnetism. Houston and Kennelly.
Chapters I–III.
What is Electricity? J. Trowbridge.
Chapter III. Magnetism.

Periodicals.

Cassier's Magazine. Vol. 13, p. 433 (March, 1898). W. A. Anthony. The Magnetic Concentration of Ores.
Proceedings of the Royal Institution. Vol. 13, p. 387 (May, 1891). J. A. Ewing. The Molecular Process in Magnetic Induction.

IX. THE MAGNETISM OF THE EARTH

Thompson, Lesson XII. Maps opposite title-page and table of contents.
Walmsley, Pages 120–138.

QUESTIONS

1. Does a compass needle generally point to the true north?

2. What are the angles of declination and of inclination?

3. Where in the United States does the needle point due north?

4. What are isogonic lines? Agonic?

5. Discuss the variations in the earth's magnetism.

6. Examine the map on page 130, *The Electric Current*, and find if different isogonals ever cross.

7. How does a dipping needle behave at the north magnetic pole? At the magnetic equator?

8. On a modern steamship how are the indications of the compass made independent of the influence of the neighboring iron?

9. From the magnetic maps determine the inclination and declination of the place where you live.

10. Of what use are magnetic observatories?

SUPPLEMENTARY READING

Books.

Magnetism. Houston and Kennelly.
Chapter X.
Traité de Magnétisme Terrestre. Mascart.

Periodicals.

Nature. Vol. 61, p. 302. (Jan. 25, 1900). Gatacre's Repulse at Stormberg.
Vol. 57, pp. 160 and 180 (Dec., 1897). A. W. Rücker. Recent Researches in Terrestrial Magnetism.
Terrestrial Magnetism. Vol. 2, p. 45 (June, 1897). J. A. Fleming. The Earth a Great Magnet.

X. THE ELECTROMAGNET

Houston and Kennelly, Leaflets 12, 13, 14, 15.
Thompson, Lessons XVI, XXVIII, XXX and XXXI, Sections 508 and 509.
Walmsley, Pages 138–169, 315-326 and 645–649.

QUESTIONS

1. A wire is stretched from north to south and is brought over a compass needle. A current flows in the wire from south to north. How is the needle deflected?

2. When a current flows through a coil, how, besides by testing, can you tell which is the north pole of the coil?

3. What are some of the uses of electromagnets?

4. What advantages are there in the use of electromagnets?

5. Explain how the electric bell operates.

6. What is hysteresis?

7. Why is it important to know the permeability of different kinds of iron and steel?

8. In designing an electromagnet, why is it desirable to have the magnetic circuit as short as possible?

9. What is meant by ampere-turns?

10. A coil is wrapped around a piece of iron and a gradually increasing current passes through the coil. How does the number of lines of force in the iron change with the current?

SUPPLEMENTARY READING

Books.

Lectures on the Electromagnet. S. P. Thompson.
The Electromagnet. S. P. Thompson.
Magnetism. Houston and Kennelly.
Chapters IV–VIII.
A Century of Electricity. T. C. Mendenhall.
Chapter III. Oersted's Discovery and the Electromagnet.
Short Lectures to Electric Artisans. J. A. Fleming.
Lectures I–IV.

Periodicals.

The Electrical Review. London, Vol. 41, p. 680 (Nov. 12, 1897). A. Jamieson. Twenty-five Years' Development in Magnetism.

XI. THE TELEGRAPH

Thompson, Lessons L, LI and LII, Sections 301, 302.

Walmsley, Pages 562-610.

Houston and Kennelly, Sections 42-46, 49, 51, 62 and 63.

QUESTIONS

1. Make diagrams of the sounder and the relay.
2. Why is the earth used as the return circuit?
3. Make a diagram showing how the instruments of two stations are connected to the line wire.
4. In sending, how does a dot differ from a dash?
5. Why is it that receiving is now done by ear?
6. When an operator opens his key, what audible and visible actions take place?
7. Why does a submarine cable act differently from an air line?
8. Compare open with closed circuit work.
9. How are the instruments in a telegraph office protected from lightning?
10. What kind of cells are used in local telegraph offices? Why?

SUPPLEMENTARY READING

Books.

Electric Telegraphy. Houston and Kennelly.
Modern Practice of the Electric Telegraph. F. L. Pope.
American Telegraphy. A. Maver, Jr.
The Story of the Atlantic Telegraph. H. M. Field.

A Century of Electricity. T. C. Mendenhall.
Chapter IV. Who Invented the Electromagnetic Telegraph?
Chapter V. Multiplex Telegraphy and Submarine Cables.
What is Electricity? J. Trowbridge.
Chapter V. The Flow of Electricity in the Earth.

Periodicals.

Electrical World and Engineer. Vol. 37, p. 44 (Jan. 5, 1901). P. B. Delany. The Telegraph.
Engineering Magazine. Vol. 16, p. 416 (Dec., 1898). Charles Bright. Extension of Submarine Telegraphy in a Quarter Century.
Nature. Vol. 55, p. 403 (Feb. 25, 1897). W. E. Ayrton. Sixty Years of Submarine Telegraphy.
The Electrical Review. London, vol. 41, p. 629 (Nov. 12, 1897). R. von Fischer Treuenfeld. Twenty-five Years' Progress in Military Telegraphy.
Vol. 41, p. 678. W. H. Preece. Twenty-five Years of Telegraphic Progress.
Vol., 41, p. 669. C. Bright. The Construction, Laying and Repairing of Submarine Telegraphs.

XII. THE VOLTAIC CELL

Houston and Kennelly, Leaflets 9, 10, 11, Sections 76 and 78.
Thompson, Lessons XIII, XIV, XV, Sections 406 and 407.
Walmsley, Pages 26–66 and 289–295.

QUESTIONS

1. Examine any cell. What substances form the electrolyte, the depolarizer, the negative and the positive plates respectively?

2. Why does not the common gravity cell give a large current?

3. Why is zinc so generally used in cells?

4. When is it advantageous to join cells in series? When in parallel?

5. The two positive poles of two exactly similar cells are joined together and also the two negative poles. Are these cells joined parallel? How much current flows?

6. Given two unlike cells, a galvanometer and connecting wires, devise a way of finding which cell has the greater E. M. F.

7. What things determine the greatest current that a cell can furnish?

8. What is polarization? What substance causes it? How is it avoided?

9. How is a dry cell made? What advantage has it?

10. Why should the zinc of a cell be amalgamated?

SUPPLEMENTARY READING

Books.

Primary Batteries. H. S. Carhart.
Short Lectures to Electric Artisans. J. A. Fleming. Lecture VIII.
Practical Electricity. W. E. Ayrton. Chapter VI.
What is Electricity? J. Trowbridge. Chapter VI.
A Century of Electricity. T. C. Mendenhall. Chapter II.

Periodicals.

Cassier's Magazine. Vol. 8, p. 131 (Jan., 1895). Henry Morton Maximum Possible Efficiency of Galvanic Batteries.
The Electrical Review. London, vol. 41, p. 688 (Nov. 12, 1897). T. E. Gatehouse. Twenty-five Years' Retrospect on Primary Galvanic Batteries.

XIII. THE CHEMICAL EFFECTS OF THE CURRENT

Thompson, Lessons XIX, XLVII and XLIX.
Walmsley, Pages 296–311 and 467–484.

QUESTIONS

1. What is meant by electrolyte, electrode, anode, kathode, anion and kation ?

2. When a direct current passes through a solution of potassium iodide, what are the kation and anion respectively ?

3. What are some of the practical uses of electrolysis ?

4. Two strips of copper dip in a tumbler containing a solution of copper sulphate. A current passes from one strip to the other. What changes take place in each strip ?

5. Can an alloy such as brass be deposited electrolytically ?

6. Find how surfaces which are to be covered with nickel are prepared for plating.

7. What is a voltameter ? What does it measure ?

8. Describe the process of electrolyzing.

9. What are Faraday's Laws of Electrolysis ?

10. How much copper is deposited by a current of 10 amperes flowing for a week ?

SUPPLEMENTARY READING

Books.

Electric Smelting and Refining. W. Borchers.

Periodicals.

Electrical World and Engineer. Vol. 37, p. 34 (Jan. 5, 1901). Carl Hering. Electrochemistry.

Cassier's Magazine. Vol. 12, p. 226 (June, 1897). F. Overbury. Electrochemistry at Niagara Falls.

Vol. 12, p. 593 (Sept., 1897). T. Ulke. Electric Copper Refining in the United States.

Engineering Magazine. Vol. 15, p. 594 (July, 1898). S. Cowper-Coles. Recent Applications of Electrochemistry to the Metal Industries.

Vol. 18, p. 389 (Dec., 1899). W. Borchers. Electrolytic Processes in Industrial Operations.

Proceedings of the Royal Institution. Vol. 13, p. 625 (1892). J. W. Swan. Electrometallurgy.

The Electrical Review. London, vol. 41, p. 637 (Nov. 12, 1897). Andreoli. The Progress of Electrochemistry during the Last Twenty-five Years.

Nature. Vol. 58, p. 112 (June 2, 1898). T. Ewan. The Industrial Applications of Electrochemistry.

XIV. THE STORAGE CELL

Thompson, Lesson XLVIII, beginning on p. 522.
Walmsley, Pages 66–89, 548, 675, 717 and 718.

QUESTIONS

1. What advantages have storage cells over primary ones?

2. Why is it more disastrous to short circuit an accumulator than a primary cell?

3. Why do storage cells have an odd number of plates?

4. How can the positive be distinguished from the negative plates?

5. What is buckling? Forming?

6. Why is the heavy metal lead used?

7. For what purposes are storage cells now employed?

8. Why cannot primary cells be practically used for the same purposes?

9. How are storage cells employed in a direct current power station?

10. Suggest some purposes to which storage cells could be applied if their weight could be considerably reduced.

SUPPLEMENTARY READING

Books.

The Storage Battery. A. Treadwell.
Electric Lighting. F. B. Crocker. Vol. I.
Chapter XX. Accumulators. Chapter XXI. Application of Accumulators in Electric Lighting.

Periodicals.

Electrical World. Vol. 33, p. 139 (Feb. 4, 1899). J. Appleton. Latest Progress in the Application of Storage Batteries.
Electrical World and Engineer. Vol. 37, p. 38 (Jan. 5, 1901). A. Treadwell. The Storage Battery.
Vol. 37, p. 867 (May 25, 1901). A. E. Kennelly. The Edison Storage Battery.
American Electrician. Vol. 12, p. 474 (Oct., 1900). E. L. Reynolds. Storage Batteries in Electric Railway Power Stations.
The Electrical Review. London, vol. 41, p. 632 (Nov. 12, 1897). Epstein. Twenty-five Years' Progress in Secondary Batteries.
Transactions of the American Institute of Electrical Engineers. Vol. 16, p. 59 (Feb., 1899). R. M. Lloyd. Storage Batteries and Railroad Power Stations. Discussion.

XV. THE PRODUCTION OF CURRENTS BY INDUCTION

Houston and Kennelly, Leaflet 16.
Walmsley, Pages 169-186 and 326-328.
Thompson, Lessons XVIII, XL, XLI.

QUESTIONS

1. Give several methods by which a current can be induced.

2. What is Lenz's law?

3. The north pole of a magnet is thrust into a coil of wire whose ends are connected. Does the induced current flow so as to make the side of the coil nearest the magnet a north or a south pole?

4. Suppose the ends of the coil are not connected. Does the entrance of the magnet produce any effect?

5. What are the important parts of the induction coil?

6. Is the induction coil used for any practical purpose?

7. What is self-induction?

8. What is the connection between lines of force and the induction of currents?

9. How does a spark-coil produce a spark?

10. How long does an induced current last?

SUPPLEMENTARY READING

Books.

A Century of Electricity. T. C. Mendenhall.
Chapter VI. Faraday's Discovery of Induction and the Development of the Dynamo.

What is Electricity? J. Trowbridge.
Chapter X. Transformation of Energy.
Chapter XIII. Self-induction.

XVI. THE TELEPHONE

Walmsley, Pages 610–645.
Thompson, Lesson LIII.

QUESTIONS

1. In what particulars does the telephone have advantages over the telegraph?

2. What is it that passes along the wire?

3. Explain how sounds are produced in the telephone receiver.

4. Where and for what purpose is carbon used in the transmitter?

5. What is the use of the induction coil in the telephone box?

6. Find how the switchboard at the exchange is arranged.

7. What changes are brought about by removing the receiver from its hook?

8. Why are two wires used now instead of one wire and an earth return as was formerly the case?

9. How is the production of induced currents in telephone lines from outside disturbing influence avoided?

10. What changes in telephone practice have you noticed in recent years?

SUPPLEMENTARY READING

Books.

American Telephone Practice. K. B. Miller.
Electric Telephone. Houston and Kennelly.
A Century of Electricity. T. C. Mendenhall. Chapter IX.
Telephone Lines and their Properties. W. J. Hopkins.

Periodicals.

Electrical World and Engineer. Vol. 37, p. 33 (Jan. 5, 1901). K. B. Miller. Telephony.
Vol. 37, p. 961 (June 8, 1901). G. De La Touanne. A European Study of American Telephone Statistics.
Engineering Magazine. Vol. 18, p. 550 (Jan., 1900). K. B. Miller. Merits of Independent and Industrial Telephone Systems.
Vol. 21, p. 105 (April, 1901). M. I. Pupin. Transatlantic Communication by Means of the Telephone.
The Electrical Review. London, vol. 41, p. 658 (Nov. 12, 1897). J. E. Kingsbury. Twenty-five Years' Development in Telephony.
Scientific American. Vol. 85, p. 24 (July 13, 1901). The Common Battery Telephone System of the City of New York.

XVII. THE CONTINUOUS CURRENT DYNAMO

Houston and Kennelly, Sections 19, 158, Leaflets 17, 18, 19, 20, Sections 120 and 150.
Thompson, Lesson XLII.
Walmsley, Pages 186–236.

QUESTIONS

1. What things determine the E. M. F. developed by a dynamo?

2. How is the current produced in a dynamo?

3. What is the use of the commutator?

4. Why is the armature core laminated?

5. Make diagrams of a series, a shunt and a compound-wound dynamo.

6. For what purposes is each of these used?

7. What kind of dynamo gives a constant difference of potential at its terminals?

8. How is an arc lighting dynamo made to give a constant current?

9. How does the turning of the handle of a rheostat in the field circuit of a shunt dynamo change the reading of the voltmeter connected to the terminals of the dynamo?

10. What are the different types of armatures?

SUPPLEMENTARY READING

Books.

Dynamo-Electric Machinery. S. P. Thompson.
What is Electricity? J. Trowbridge. Chapter VIII.
Electric Lighting. F. B. Crocker. Vol. 1, chapters XVII–XIX.
Dynamo-electric Machines. Direct Current Machines. S. Sheldon. The last book will be found to be very helpful for both continuous current dynamos and motors.

Periodicals.

The Electrical Review. London, vol. 41, p. 627 (Nov. 12, 1897). W. B. Esson. Twenty-five Years of Dynamo-electric Machinery.

XVIII. THE CONTINUOUS CURRENT MOTOR

Houston and Kennelly, Leaflets 21, 22, 23, 24.
Thompson, Lesson XXXII, Sections 443–445.
Walmsley, Pages 695–708.

QUESTIONS

In the following group of questions the word motor will be understood to mean continuous current motor.

1. Why does the armature of a motor rotate?

2. Explain the counter electromotive force of a motor.

3. Suppose the load of a motor to be removed. What things set a limit to the speed of rotation of its armature?

4. A motor is working under a load when for some reason the current ceases. What objection is there to letting the motor remain just as it is until the current is again turned on?

5. What are the chief uses of the motor?

6. An ammeter is put in the circuit of a small series motor and the latter is connected directly to the supply mains. As the motor speeds up the number of amperes falls. Why is this?

7. How may a shunt motor on constant potential mains be made to run with constant speed under variable load?

8. How can the direction of rotation of a motor be reversed?

9. How can the speed of a series motor on constant potential mains be regulated?

10. Why is it more important to have resistance in circuit at the time of starting with a shunt than with a series motor?

SUPPLEMENTARY READING

Books.

Dynamo-electric Machinery. S. P. Thompson.
Dynamo-electric Machines. Direct Current Machines. S. Sheldon.
The Electric Motor. Houston and Kennelly.
Power Transmission by Electricity. P. Atkinson.

Periodicals.

Electrical World and Engineer. Vol. 37, p. 350 (March 2, 1901). A. D. Adams. Development of Fan Motors.
American Electrician. Vol. 12, p. 167 (April, 1900). Fan Motors for 1900.
Vol. 13, p. 158 (April, 1901). Fan Motors for 1901.
Cassier's Magazine. Vol. 7, p. 393 (March, 1895). F. B. Crocker. The Electric Motor.

XIX. ALTERNATING CURRENTS

Houston and Kennelly, Leaflets 30, 31, 32.
Thompson, Lesson XLIII.
Walmsley, Pages 425–462.

QUESTIONS

1. What is an alternating current?

2. In a wire carrying an alternating current is there ever a time when there is no current?

3. What is the relation between the number of alternations and the number of cycles per sec.?

4. In dealing with alternating currents what holds the same place as resistance with continuous currents?

5. An alternating current is flowing through a coil A piece of iron is thrust into the coil. What effect does this have upon the strength of the current?

6. When can Ohm's Law be applied to calculate approximately the strength of an alternating current?

7. What is a choking coil and for what is it used?

8. What is the power factor of a circuit?

9. What is the skin effect? What causes it?

10. What is meant by saying that the current lags behind the impressed E. M. F.?

SUPPLEMENTARY READING

Books.

Alternating Electric Currents. Houston and Kennelly.
Electric Lighting. F. B. Crocker. Vol. 2.
Chapter VII. Principles of Alternating Currents.
Chapter VIII. Principles of Alternating Polyphase Currents.
Dynamo-electric Machinery. S. P. Thompson. Chapter XXII.
Alternate Current Working. A. Hay. This book is only slightly mathematical, and is written with remarkable clearness.
The Alternating Current Circuit. W. P. Maycock.
What is Electricity? J. Trowbridge. Chapter XI.

Periodicals.

Electrical World. Vol. 15, p. 274 (April 19, 1890). Elihu Thomson. Phenomena of Alternating Current Induction.
Electrical World and Engineer. Vol. 33, p. 267 (Mar. 4, 1899). Houston and Kennelly. Alternating Currents Twenty-five Years Ago and Today.
Vol. 35, pp. 399, 433 (Mar. 17, 1900). D. C. Jackson. Fundamental Ideas of Alternating Currents.
Cassier's Magazine. Vol. 14, p. 406 (Sept., 1898). H. A. Wagner. General Distribution from Electric Central Stations by Alternating Currents.
Proceedings of the Royal Institution. Vol. 13, p. 296. J. A. Fleming. Electromagnetic Repulsion.

XX. THE ALTERNATOR

Houston and Kennelly, Leaflets 33 and 34.
Thompson, Lesson XLIV.
Walmsley, Pages 236–243, 459–461.

QUESTIONS

1. How does the current get from the rotating armature to the external circuit?

2. Why do alternators have a separate exciter for the field?

3. What advantage is there in having the field rotate instead of the armature?

4. What things determine the number of alternations per second?

5. Why are higher voltages employed with alternating than with continuous currents?

6. Explain what is meant by saying that two alternators are in phase with one another.

7. What disadvantage is there in the series winding of an alternator armature?

8. In the United States what kinds of armatures are commonly used in alternators?

9. How are arc light alternators made to give a constant current?

10. How can you tell an alternator from a continuous current dynamo?

SUPPLEMENTARY READING

Books.

Dynamo-electric Machinery. S. P. Thompson. Chap. XXIII.
Electric Lighting. F. B. Crocker. Vol. 1, pp. 287–289, 338 and 339.

XXI. THE ALTERNATING CURRENT MOTOR

Walmsley, Pages 709–713.
Thompson, Lesson XLVI.
Houston and Kennelly, Sections 296–299.

QUESTIONS

1. What is a synchronous motor?

2. Mention some disadvantages of synchronous motors.

3. Give some advantages of induction motors.

4. Explain how a rotating magnetic field is produced.

5. Describe the currents generated by diphasers, triphasers and monocyclic alternators.

6. What is the difference between mesh and star grouping?

7. How many wires are used to transmit diphase currents? Triphase?

8. What are the rotor and the stator?

9. How is the current in the winding of the rotor produced?

10. Why does the rotor revolve?

SUPPLEMENTARY READING

Books.

Polyphase Electric Currents and Alternating Current Motors. S. P. Thompson.
The Electric Motor. Houston and Kennelly. Chapter IX.
Dynamo-Electric Machinery. S. P. Thompson. Chapter XXIV.

Periodicals.

Electrical World and Engineer. Vol. 35, pp. 168, 214 (Feb., 1900). R. D. Mershon. The Polyphase Induction Motor. Vol. 37, pp. 957 and 966 (June, 1901). R. D. Mershon. The Polyphase Induction Motor for General Power Service.

American Electrician. Vol. 9, p. 204 (June, 1897). E. J. Berg. Single Phase Motors.

Vol. 10, pp. 193, 317, 372, 420 (May-Sept., 1898). A. E. Wiener. The Induction Motor.

Vol. 11, p. 17 (Jan., 1899). E. J. Berg. Alternating Current and Synchronous and Induction Motors.

Vol. 11, p. 63 (Feb., 1899). E. J. Berg. Polyphase and Single-phase Alternating Current Induction Motors.

Vol. 11, p. 121 (Mar., 1899). W. Baxter, Jr. How Energy is Transferred from the Primary to the Secondary in Induction Motors.

Vol. 12, p. 371 (Aug., 1900). The Polyphase Power Distributing System of the Deering Harvester Co.

Vol. 13, p. 158 (April, 1901). Fan Motors for 1901.

Vol. 13, pp. 87, 132, 190, 238, 307, 362, 407. Lessons in Practical Electricity.

Cassier's Magazine. Vol. 20, p. 327 (Aug., 1901). T. P. Gaylord. Alternating Current Power Work.

XXII. THE ALTERNATING CURRENT TRANSFORMER

Houston and Kennelly, Leaflet 35 and Section 135.
Thompson, Lesson XLV and Section 228.
Walmsley, Pages 673–695, 656 and 668.

QUESTIONS

1. For what are transformers used?

2. What are the essential parts of transformers?

3. What determines the number of volts developed in the secondary of a transformer?

4. Compare the transformer with the induction coil.

5. For what purpose and in what direction are the iron cores of transformers laminated?

6. Does a continuous or an alternating current flow in the secondary of a transformer?

7. Why do not transformers deliver as much energy as they receive?

8. How is the current in the secondary produced?

9. When transformers on a constant potential circuit are used to feed incandescent lamps, how are they joined to the circuit?

10. In a transformer joined to constant potential mains, why does more current flow through the primary when the lamps joined to the secondary are burning than when they are turned off.

SUPPLEMENTARY READING

Books.

Electric Lighting. F. B. Crocker. Vol. 2, chapter IX.
Dynamo-electric Machinery. S. P. Thompson. Chapter XXV.
Transformers. C. D. Haskins. 1892.

Periodicals.

American Electrician. Vol. 12, pp. 192, 238, 302, 356, 407, 445, 499, 541, 583 (1900): and vol. 13, p. 44. Lessons in Practical Electricity.
The Electrical Review. London, vol. 41, p. 647 (Nov. 12, 1897). J. Swinburne. Transformers.

XXIII. THE ELECTRIC TRANSMISSION OF POWER

Walmsley, Pages 650-673, 753–754 and 542–552.
Thompson, Section 447.

QUESTIONS

1. What advantages has the transmission of power by the electric current over other methods of transmission?

2. Why are alternating currents used for long distance transmission?

3. Why are high voltages used for long distance transmission?

4. What economic changes will probably take place owing to this method of transmitting energy?

5. Where do the losses occur in electric transmission?

6. Study the transmission and development of power at Niagara Falls.

7. What part does the transformer play in the transmission of power?

8. What sets a lower limit to the diameter of the wire used in transmission systems? What an upper limit?

9. What advantages has the three-wire system for local power transmission by direct current?

10. Find what methods of transmitting energy electrically are used in the town where you live.

SUPPLEMENTARY READING

Books.

Electrical Transmission of Energy. A. V. Abbott.
Power Transmitted by Electricity. P. Atkinson.
The Electric Motor. Houston and Kennelly. Chapter VIII.
Electric Power Transmission. L. Bell.
Electric Transmission of Energy. G. Kapp.
Dynamo-electric Machinery. S. P. Thompson. Chapter XXVI.
What is Electricity? J. Trowbridge. Chapter XII.

Periodicals.

Electrical World. Vol. 33, p. 1 (Jan. 7, 1899). J. E. Woodbridge. The Niagara Falls Power Plant.
Vol. 33, p. 43 (Jan. 14, 1899). The Power Plant of the Niagara Falls Hydraulic Power and Manufacturing Co.
Vol. 33, p. 47 (Jan. 14, 1899). The Canadian Power Plant.
Vol. 33, p. 76 (Jan 21, 1899). The Delivery and Distribution of Niagara Power at Buffalo.

Vol. 33, pp. 833, 869 (1899), and vol. 34, pp. 77, 117, 153, 189, 225, 265, 409, 569, 999. E. M. Archibald. Canadian Water Power Electric Plants.

Vol. 37, p. 31 (Jan. 5, 1901). L. Bell. Electrical Power Transmission.

Vol. 37, pp. 503 and 593 (March 30, 1901). J. R. Cravath. Power Transmission in Utah.

American Electrician. Vol. 9, p. 205 (1897). L. Bell. Economics of Power Transmission.

Vol. 9, p. 211, Electricity at Niagara Falls. This periodical for Jan. and Feb., 1900, contains several finely illustrated articles upon the Niagara power system.

Cassier's Magazine. Vol. 8 (1895). The July number has about 200 pages upon the Niagara system, finely illustrated.

Vol. 11, p. 104 (Dec., 1896). L. Duncan. Power Transmission by Alternating Currents.

Vol. 12, p. 3 (May, 1897). J. E. Bennett. Electric Power from High Water Heads.

Vol. 12, p. 145 (June, 1897). A. B. Blainey. Electric Power at High Altitudes.

Vol. 15, p. 331 (March, 1899). A. O. Dubsky. The Rome-Tivoli Electric Installation.

Vol. 17, p. 3 (Nov., 1899). J. A. Lighthipe. An 83-Mile Electric Power Transmission Plant.

Vol. 17, p. 113 (Dec., 1899). L. Bell. Practical Limitations of Electric Power Transmission.

Vol. 20, p. 3 (May, 1901). H. W. Buck. Niagara Falls Power.

Engineering Magazine. Vol. 15, p. 1011 (March, 1898). F. C. Finkle. The Electric Development of Hydraulic Power.

Vol. 17, p. 778 (Aug., 1899). E. Bignami. The Utilization of the Water Powers of Italy.

Vol. 17, p. 827 (Aug., 1899). J. Swinburne. Short Distance Electric Power Distribution.

Vol. 17, p. 953 (Sept., 1899). T. Tonge. Electricity in the Mines at Cripple Creek.

Vol. 18, p. 69 (Oct., 1899). L. Bell. Electric Power in Engineering Works.

Vol. 18, p. 169 (Nov., 1899). L. Bell. Electric Power Distribution and the Small Consumer.

Proceedings of the Royal Institution. Vol. 15, p. 269. T. C. Martin. The Utilization of Niagara.

Journal of the Franklin Institute. Vol. 148, p. 161 (Sept., 1899). B. C. Washington, Jr. Water Power Electrical Plants in the United States.

The Electrical Review. London, vol. 41, p. 652 (Nov. 12, 1897). R. Kennedy. Twenty-five Years of Transmission of Power by Electricity.

Annual Report of the Smithsonian Institution. P. 207 (1896). L. Duncan. Present Status of the Transmission and Distribution of Electrical Energy. P. 223. T. C. Martin. The Utilization of Niagara.

Transactions of the American Institute of Electrical Engineers. Vol. 15, p. 673 (June, 1898). C. F. Scott. High Voltage Power Transmission.

XXIV. THE ELECTRIC RAILWAY

Thompson, Section 446.
Walmsley, Pages 713–747.

QUESTIONS

1. Trace the path of the current from the power house, through the line and the car back to the power house.

2. Describe the structure of the controller.

3. How are the incandescent lamps in the car connected?

4. What is a running point on the controller?

5. What advantages has electric traction over other systems?

6. What changes in the distribution of population has electric traction brought about?

7. Why are metal pipes laid in the ground near electric railways corroded?

8. What kind of motors are used on electric railways?

9. If possible visit a power house.

10. How are the rails of the track electrically connected?

SUPPLEMENTARY READING

Books.

The Electric Street Railway. Houston and Kennelly.
Power Transmitted by Electricity. P. Atkinson.
Power Distribution for Electric Railroads. L. Bell.
Modern Electric Railway Motors. G. T. Hanchett.
The Electric Railway. Crosby and Bell.

Periodicals.

Electrical World and Engineer. Vol. 31, pp. 23, 67 (Jan. 1, 1898). L. Bell. Some Difficulties of Heavy Electric Railroading.
Vol. 31, p. 21 (Jan. 1, 1898). A. Blondel. Remarks upon Long Distance Transmission for Electric Traction.
Vol. 31, pp. 21 and 65 (Jan. 1, 1898.) H. P. Brown. The Evolution of the Railbond.
Vol. 31, p. 20 (Jan. 1, 1898). C. P. Steinmetz. Use of Polyphase Motors on Electric Railroads.
Vol. 37, p. 82 (Jan. 12, 1901). Behrend and Wessling. The Future of the Electric Railway.

Cassier's Magazine. Vol. 16, for Aug., 1899, contains about 300 pages treating the electric railway from many points of view. The articles are well illustrated.
Vol. 20, p. 75 (May, 1901). C. F. Bancroft. Electric Distribution for Street Railways.

Engineering Magazine. Vol. 15, p. 811 (Aug., 1898). Davis and Forbes. The Application of Alternating Currents to Electric Traction.

Journal of the Franklin Institute. Vol. 147, pp. 315, 344 (1899). E. E. Higgins. Some of the Larger Transportation Problems in Cities.

The Street Railway Journal. Vol. 15, for Oct., 1899, has a series of articles describing the railroads in different countries.

Popular Science Monthly. Vol. 56, pp. 316, 409 and 564 (Jan.–March, 1900). Wm. Baxter, Jr. What Makes a Trolley Car Go?
Vol., 56, p. 357 (Jan., 1900). H. S. Wynkoop. Destructive Effects of Vagrant Electricity.

Transactions of the American Institute of Electrical Engineers. Vol. 15, p. 427 (June, 1898). Power Transmission and Distribution for Railway Work.

The Electrical Review. London, vol. 41, p. 676 (Nov. 12, 1897). P. Dawson. Twenty-five Years of Electric Traction.

XXV. WIRELESS TELEGRAPHY

Walmsley, Pages 462–466.

Thompson, Lessons LIV and LV.

For the recent developments of wireless telegraphy the reader is referred to the Supplementary Readings.

SUPPLEMENTARY READING

Books.

Wireless Telegraphy Popularly Explained. R. Kerr.

Signalling Through Space without Wires. O. Lodge.

A History of Wireless Telegraphy. J. J. Fahie.

Modern Views of Electricity. O. Lodge. Part IV. Radiation.

What is Electricity? J. Trowbridge. Chapters XIV–XIX.

Periodicals.

Electrical World and Engineer. Vol. 33, pp. 616, 652, 701, 749, 802 (May and June, 1899). A. V. Abbott. Electric Radiation. Vol. 37, p. 37 (Jan. 5, 1901). A. V. Abbott. Wireless Telegraphy.

Engineering Magazine. Vol. 18, p. 746 (Feb., 1900). P. B. Delany. The Development of Wireless Telegraphy.

Proceedings of the Royal Institution. Vol. 13, p. 77 (March, 1890). G. F. FitzGerald. Electromagnetic Radiation.

Western Electrician. Vol. 25, p. 213 (Oct. 14, 1899). Marconi and His Wireless-Telegraph System at the International Yacht Races of 1899.

Popular Science Monthly. Vol. 56, p. 59 (Nov., 1899). J. Trowbridge. Wireless Telegraphy.

Report of the Smithsonian Institution for 1896. P. 235. S. P. Thompson. Telegraphy across Space.

Transactions of the American Institute of Electrical Engineers. Vol. 16, p. 635 (Nov., 1899). The Possibilities of Wireless Telegraphy.

Reading Courses in Electricity: *Some Suggestions*

by ELIHU THOMSON

Reading Courses in Electricity: *Some Suggestions*

by ELIHU THOMSON

Dr. Elihu Thomson ranks with the greatest electrical engineers of the world. Born in England, of Scotch-English parentage, he has since childhood resided in this country. Upon his graduation from the Central High School of Philadelphia in 1870, he became a member of its faculty. The last twenty years have been dedicated to practical work as electrician for the American Electric Company, later known, as the Thomson-Houston Company. This in turn consolidated with the Edison General Electric Company in 1892, forming the General Electric Company, in which Dr. Thomson is still active as inventor and general consulting engineer. More than five hundred patents have been obtained for inventions, some of which have revolutionized certain lines of manufacture. These include the Thomson system of electric welding. His recording watt-metre divided with one other competitor the first prize awarded by the Paris Commission of 1890. Honorary degrees were conferred upon him by Tufts College and Yale University, and in one year, 1889, he received the three-fold distinction of an election to the presidency of the American Institute of Electrical Engineers, the order of Officer of the Legion of Honor and the award of the Grand Prix for apparatus exhibited at the Paris Exposition.

In order to reap full benefit from a course of reading in applied science there is needed first of all a certain background of experience or contact with the realities dealt with. The study from

books should properly be supplemental to the training in the laboratory or workshop, using these latter terms in their broadest sense. To be able justly to interpret the printed page bearing upon technical subjects demands acquaintance with actual operations upon which the imagination of the reader may build. Our power to adopt the experience of others at its true value depends upon the possession of like experience of our own. We interpret a picture of a landscape, for example, by our actual knowledge of similar scenes supplying the lacking third dimension which gives depth, distance or stereoscopic character. The same principle holds in our reading, more particularly when it relates to real objects of sense. There would be no need for the elaborate laboratory equipments of our schools and universities if we could afford to neglect the conditions above related.

It is true also that to be well informed today, to possess culture in the modern sense, involves a certain familiarity with the results of science and the methods of investigation employed in its pursuit. Perhaps this is the natural offset to the waning interest in ancient classical literature and bygone superstitions. Moreover, the study of the sciences is so closely linked with the enormous modern development of engineering and the industries founded thereon, that, from the utilitarian aspect alone its increasing importance is manifest.

The modern man of business is the better equipped if he has in him something of the engineer, and the engineer today must often combine in himself the qualities of the successful business man. The ever-widening field of applied science, devoid of stagnation, has a great fascination for active, progressive minds. Need we say that applied electricity is a striking example? Broadly, the study of electricity is part of the border field of physical science, and earnest reading concerning its important applications presupposes a general knowledge of physical and chemical principles. Without this the interest of the reader is likely to be checked, at times, in spite of his earnest purpose.

The necessity of care in the selection of reading need scarcely be pointed out. There are many books in existence which deal with the entertaining and fascinating, which display the goings-on in the modern fairyland of electricity, or which relate in a popular, and it may be in an artistic way, the more striking or astonishing achievements. They hardly form the basis of serious study yet as an entertainment they are to be welcomed if the common faults of substituting fiction for fact and using exaggeration as a stimulus are absent. They may possibly engender an interest leading afterward to closer and deeper study; as a tree begins its growth in the lighter surface-soil before taking root in the firmer earth beneath. Another considerable class of books on applied electricity can

only be mentioned for condemnation. They are padded volumes, compilations from trade catalogues with illustrations such as are most readily to be found at hand; the text, when original, is generally poor and the whole work unintelligent and slipshod. Such books being made only to sell to the unwary, are to be avoided, however widely advertised. Promising titles such as *Electric Motors and All About Them* in the shape of small volumes of coarse print sufficiently characterize such productions. Luckily fewer of them now exist than formerly.

In beginning a course of reading the guidance of those who are familiar with actual practical work will be almost essential. The student, earnest in purpose, will need some standard volume devoted to the fundamental principles and facts in electricity and magnetism, as a preparation for subsequent works dealing more particularly with the uses and applications. The habit of close thinking and thoroughness becomes easy by practice. Matters at first seemingly difficult, or demanding effort to comprehend, should be attentively studied. Half knowledge is frequently synonymous with false knowledge.

To avoid the unconscious absorption of obsolete ideas, the most profitable reading for a beginner will be found in the later or newer books or editions, particularly those published within the past ten years. Afterward he may turn with interest

and pleasure to the older standard works, or to the many books and papers in which may be traced the evolution of the science and its applications. Should he then fail to meet much to broaden, inspire and assist him to an understanding of the mission of science, the fault will be in himself. He could not fail to conceive a certain deep respect and admiration for the early workers who, despite meagre facilities and many obstacles, did so much to lay the foundations for the enormous progress in later years; a progress which has already had a most profound influence in improving the conditions of human existence.

Elihu Thomson.

The Study *of* Electrical Engineering: *A Ten-Minute Talk by* EDWIN J. HOUSTON

The Study *of* Electrical Engineering: *A Ten-Minute Talk by* EDWIN J. HOUSTON

Dr. Edwin James Houston began his professional career as a teacher of physics in the Boys' High School, of Philadelphia. In collaboration with Dr. Elihu Thomson, who was then his colleague in the High School, he has played an important part in the development of electrical appliances in the United States. The Thomson-Houston system of electric lighting was the beginning of a long series of important inventions which are familiar under the joint name to electrical engineers. Dr. Houston was chief electrical engineer of the International Electrical Exposition of 1884, and for two successive years held the presidency of the American Institute of Electrical Engineers. He is now a consulting engineer in Philadelphia in partnership with Dr. Arthur E. Kennelly. Dr. Houston is the author of a large number of works on electricity and general and geographical physics. His recent books have been written in collaboration with Dr. Kennelly. The most important of these joint works are the *Electro-Technical Series* of ten volumes, the *Electrical Engineering Leaflets* of three volumes, and *Recent Types of Dynamo-Electric Machinery.*

There is no subject of greater practical industrial importance at the present time than applied electricity. It forms a large and ever-widening branch of applied physical science or engineering. The great and striking change in the modern methods of production and manufacture, by con-

trast with the methods which existed in past centuries, lies in the development and use of machines and machinery, whereby muscular power has become superseded by mechanical power. In other words, the machine tool has replaced the human hand. The machine tool can operate not only more swiftly and certainly than the hand, but also more powerfully and without fatigue. Broadly speaking, mechanical power can be electrically transmitted to a distance from its point of generation more cheaply, effectively and conveniently than by any other known means; and it is, probably, largely for this reason that electrical processes and systems of operation have made such rapid strides during the past few decades. In addition to the transmission of electric power, either for the purpose of transmitting intelligence or of driving machinery, there are numerous electrical processes of chemical, thermal, magnetic and miscellaneous natures which are of great industrial importance. In fact, the age in which we now live may be regarded as the electric age by contrast with pre-existing epochs. It becomes, therefore, of the greatest importance that not only electrical engineers should be thoroughly versed in the fundamental laws of electricity and in their practical applications, but even that all educated men should be generally acquainted with the outlines of electromagnetic science.

It is now no longer correct to say that either electricity or electrical engineering is in its infancy. As a matter of fact, although the applications of electricity may, perhaps, be infantile by comparison with what the future may develop and witness, yet applied electricity has advanced so rapidly in the past thirty years that it is at least abreast of civil and mechanical engineering. Dynamo-electric machines, up to sizes of several thousands of horse-power, can be designed and constructed which shall operate within very closely predetermined and guaranteed limits in commercial service, as to speed, output, regulation, heating and other essential particulars. No science can be said to be in an immature or infantile condition which enables such results to be commercially effected as matters of everyday experience. Strange as it may seem, although the fundamental nature of electricity remains in dispute, yet the science of applied electricity affords a higher degree of commercial accuracy of measurement and pre-determination than any of the sister sciences in their commercial applications.

If the student of applied electricity would rise above the rank of a mere empiricist, acquainted with the practical application of some particular piece of electrical mechanism, it is absolutely necessary that he should familiarize himself by study and labor with the fundamental principles which underlie all electrical phenomena. Although

by such labor the descent from the general to the particular is protracted and deferred, yet when such descent is rendered possible in the natural course and development of his study, the mental grasp and effectiveness of his comprehension will be far greater and far more useful than if a shorter cut to knowledge had been attempted. It is for this reason that an adequate study of electricity must necessarily be a slow and laborious one, commencing with the fundamental principles of the science and gradually expanding towards practical developments of it. There is no royal road to learning, and in this, as in all other departments of human activity, ample labor must be expended for an ample return.

The tendency of electrical engineering and technology is towards a closer union with, and not a differentiation from, mechanical engineering and general technology. It is true that in order to acquire proficiency in this particular department, special and detailed attention must be devoted to purely electrical and magnetic principles and their application; but the highest utility and application of those principles are obtained only by judicious union with mechanical engineering and its application, since in their highest development all branches of technology unite on common ground, and each department should be studied with reference to ultimate combination with the remaining departments, since isolation

necessarily involves wastefulness of effort and opposition to the best needs of the community.

The science of electricity was formerly divided into the branches of high-tension and low-tension electricity, obtained from the frictional electric machine and the voltaic battery, respectively, while magnetism was similarly divided into permanent magnetism and electromagnetism. At the present time, however, these various branches are so intimately interconnected, both theoretically and practically, that it is no longer possible to maintain a sharp line of division between them. Electricity can no longer properly be studied from a divided high-tension and low-tension standpoint, since electrical circuits are scarcely to be differentiated along such narrowly drawn theoretical lines. Moreover, magnetics and electrics are now so closely correlated that it is impossible to obtain manifestation of one without producing phenomena of the other, and the tendency is to unite these two sets of phenomena more and more closely. In fact, the outcome of latter-day physical progress has been to show that in the future electricity and magnetism are mere departments of one great science of energy, and that thermal, luminous, mechanical, electric and magnetic phenomena are multiform manifestations of energy in varied aspects, appealing to our different organs of sensation, in accordance with their own inherent peculiarities.

It is commonly but erroneously supposed that electrical study is essentially a mathematical study. That this is an error is shown by the fact that some of the greatest workers in electricity, such as Faraday, or, in its applications, as Edison, have not been skilled mathematicians. On the other hand, however, inasmuch as the universe, as we find it, is exact in all the relations of its parts and obeys accurate quantitative laws, it follows that any part of the natural phenomena of the universe, such as electricity, is subject to the common law of m.thematics or quantitative relationship, and that such relationships naturally fall into the department of mathematics for their study and appreciation. Consequently, any deep-seated study of electricity or electrical processes must involve a knowledge of quantitative relationships, and, by consequence, at least a certain amount of mathematics; but the fundamental truths and laws of natural knowledge, or of electricity in particular, do not necessarily require mathematics for their expression.

The practical application of electricity may be divided into two broad classes; namely, the transmission of power and the transformation of power. The transmission of power covers not only such large fields of industrial utility as electric street-car driving or the transmission of electrical power from water-powers, as that of Niagara; but also cases where the power transmit-

ted is minute, though highly differentiated in its capabilities, as in electrical transmission of power for carrying speech in telephony, or carrying communication, as in telegraphy, either with or without wires. The transformation of power by electricity covers not only such cases of industrial application as electric lighting, but also electro-chemistry, electric heating and electric storage. Under one or other of these two fundamental classes every industrial application of electricity may be grouped.

The main object of the electric transmission of power is to obtain either the power itself at a point distant from the place of generation, as in the operation of distant electric motors, or to obtain some particular electric utility at a distance, as in the telephonic transmission of speech. The main object of the electric transformation of power is to obtain one or another of the many useful effects which electricity is capable of producing, under special conditions, where that effect will be commercially useful.

In every industrial application, either of the transmission or of the transformation of electric power, the object is to produce a given desired result more cheaply or conveniently than the same result could be obtained without the use of this peculiar form of energy. As distinguished from this industrial aim it must not be forgotten that the study of electricity or even of applied

electricity does not necessarily involve the question of economics.

It should be the object of the student to acquaint himself thoroughly with the fundamental principles of electromagnetics, as the common basis upon which all departments of electrical applications necessarily rest, and then to take up the study of the details and practical considerations of some particular application, with which it is his intention to familiarize himself. The range of practical and industrial applications is now so wide that it is preferable for a student to familiarize himself with the details of a single branch of industry rather than to seek a more generalized acquaintance with a number of them. It would, however, be a great mistake to attempt the study of the practical details of any line of application without first having mastered the broad principles of the science.

Edwin J. Houston

The Equipment *of the* Electrical Engineer: *A Talk* by CARL HERING

The Equipment *of the* Electrical Engineer: *A Talk* by CARL HERING

After a post-graduate course at Darmstadt, Germany, and receiving the degree of M.E. from the University of Pennsylvania (1887), Mr. Carl Hering returned for several years to his *Alma Mater* as instructor. His practical work in electrical engineering has been done in Frankfort, Paris and Philadelphia. He now resides in the latter city. He writes for technical periodicals and for some years has contributed the "Digest of Electrical Literature" to the weekly issues of the *Electrical World*. His publications include: *Principles of Dynamo-Electric Machines*, *Recent Progress in Electric Railways* and a voluminous report for the United States Government on *Electricity* at the Paris Universal Exposition of 1889. Mr. Hering was president of the American Institute of Electrical Engineers in 1900, and represented the Institute at the Paris Exposition. He has been a delegate of the United States Government to foreign exhibitions and congresses, he was a member of the electrical jury of the Export Exposition held in Philadelphia in 1899, and he served as chairman of the electrical jury of the Pan-American Exposition.

There are at least two occasions in a young man's life when he should take the greatest possible care in making a proper choice, as a mistake made at those critical periods may seriously injure, if not ruin, the career of even the

most promising young man. One of these is when he makes his choice of the profession or vocation to which he is best suited, and the other is when he makes his choice of the wife who is best suited to him. There are few things in a man's later life that are sadder than to realize, when too late, that he could have done much better had he been more careful in the proper selection of his life's work.

There was a time, not many years ago, when the development in the science and application of electricity was so rapid that very many young men decided to become electricians, some because they really had a taste for it, others merely because they thought they could amass fortunes most rapidly in that profession or business. The natural result is that there are now more so-called electricians or electrical engineers than are needed. But as in all professions or trades, there is always room for those who really have a liking for it and sufficient ambition and energy to perfect themselves in it. The young man in making his choice should therefore consider whether he has sufficient ambition, mental ability and perseverance to stand a chance of competing successfully with others who are laboring in the same field.

Let us see what a student of electrical engineering has before him. Not many years ago it was a common saying that "electricity is in its infancy" and it was not difficult at that time, by compara-

tively little reading and study, to learn a great part of what was known about the science of electricity, at least as far as its practical applications were concerned. But that time is past. A vast amount of knowledge about electricity and its properties has now been accumulated, much more than any one man could acquire in a lifetime, and to do well in his chosen profession a student of electrical engineering must, therefore, at the start be willing to do much studying and reading. Otherwise he can never expect to become more than a wireman or dynamo tender whose work day after day is the same. He who thinks that electricity is still in its infancy and that he can therefore get along with a smattering of a few of the first principles, will soon find that he has made a great mistake.

The quickest and most thorough way to acquire the necessary education as an electrical engineer in the broadest sense, is to take a complete course in some good college, and to include as much mathematics, mechanics, physics and chemistry, with laboratory and shop practice, as time and strength permit. But those who are not so fortunate as to be able to take a college course, need not despair, as they can, with patience, acquire much of the same knowledge by judicious reading and home study, although the absence of the instructor and of laboratory facilities will lengthen the time somewhat.

First of all he should get a general insight into the subject, by reading some good books of a general and introductory character without much theory or mathematics. If this interests him, he should then read books of a higher order on electricity, but not yet the more advanced treatises. At the same time he should get a general knowledge of elementary algebra, trigonometry, plane geometry, mechanics, physics and chemistry. He should by all means not neglect to familiarize himself perfectly with the meaning of curves drawn on a system of coördinates, and he should know how to plot such curves. This is so simple and so easy to understand and is so much used at present, that it ought to be taught in all preparatory schools. Nor should he fail to familiarize himself with the use of that valuable and indispensable little tool, the "slide-rule." It takes but a short time to understand its use and after some practice the student, and especially the practical engineer, will feel it a hardship to go back to the use of paper and pencil for making his calculations.

This preliminary course of reading should be accompanied by as much practical work as possible. If the student is at the time engaged in some electrical establishment, he will have opportunities, if he seeks them, of watching and perhaps assisting his superiors. If he is not so engaged a few batteries and crude instruments at home will be of

great value in carrying out some of the experiments described in his books.

After the above-mentioned preliminary course of reading, the student is ready for the more advanced works on electricity and the closely allied subjects. As the subject of alternating currents requires a knowledge of no small amount of mathematics, he should not fail to study the latter even if it is not a pleasure. If he is not able to study the higher mathematics, he will have to make up his mind to have as little as possible to do with the design and construction of alternating current machinery and systems of transmission and distribution and to limit himself to such branches as continuous current systems, telegraphy and telephony, electrochemistry, etc.

Too much stress cannot be laid on the importance of a thorough knowledge of some of the fundamental principles of science in general and of this one in particular, as many of them are constantly met with in practice. The man who gets his knowledge from books alone, is too apt to undervalue these fundamental principles. He often spends much time, labor and money trying to do that which is impossible. Among these may be mentioned electrical perpetual motions, such as machine batteries, which give out more energy than is put into them. Much time has also been lost trying to devise continuous current machines without commutators, which a knowledge of the under-

lying principles would at once have shown to be inoperative. There are many of these impossible problems on which much valuable time and energy are wasted, chiefly by those who do not understand or do not accept the fundamental principles, like that of the conservation of energy. There are also other problems which, though not necessarily impossible, have nevertheless baffled the ablest men for years. Among these are the direct generation of electricity from fuel, without the intervention of the wasteful steam engine ; or the direct production of light from electrical energy. The student should remember that some of the greatest minds have been at work at these problems for years, and that he had, therefore, better leave them to those who have been able to study the many principles involved more thoroughly than he has. He would be likely to accomplish more by devoting himself to regular engineering work.

In selecting books on electrical subjects, the student should in general choose the later ones, as so much progress has been made, and so many new terms, expressions and ways of conceiving and dealing with certain phenomena have come into use that books written a number of years ago are apt to be out of date. If he began with such books he would not only have greater difficulty in understanding the subject, but he would probably have to unlearn much that he had learned. He will find some of the best and newest reading

matter in the journals, but they should only be used to supplement the regular treatises, and not to supplant them. Moreover, he should prefer books which are intended for self-study, as distinguished from those which are intended to be accompanied by the personal guidance of an instructor.

Books on mathematics should preferably be such as are intended for electrical engineers and which dwell more particularly on those problems which arise in his work. A word might here be added concerning formulæ and algebra. Many who have not studied algebra look upon formulæ and simple algebraic expressions as something which only college students and professors can understand. This is entirely erroneous; a formula is merely a "rule" expressed in a much simpler way than is possible by the use of language. In most cases one has merely to substitute for the letters in a formula, the numerical values of a particular problem, and these, after the necessary mathematical calculations are made, give the result sought. The student will make a great mistake if he thinks formulæ and elementary algebra are too difficult to understand; they are really easier to work with than what they replace.

Many people think that studying a science is merely a storing of information in the mind, just as we store books in our library. This would put us on a par with mere parrots, who can repeat

just what they have been taught, but nothing more. True study, at least of the engineering profession, is much more than this—it is not only a storing of information, but it is, and perhaps more largely, a mental training or mental gymnastics. It should develop our thinking qualities and teach us how to think, rather than give us the information itself; the latter is best found and kept in our books of reference. The problems which we meet with in practice are seldom the same as those worked out in our books of instruction, and the student who has studied like a parrot will therefore be much less able to solve such practical problems than the one who has taught and trained himself to think. It is therefore unnecessary for the student of engineering to try to remember all he reads. It is much more important that he should understand it and be able to apply it in practice. It may often be more difficult to understand something than to remember it, but this should not discourage him; let him, in such cases, pass it by for the time, and come back to it again after he has read on. In the same way it is often of advantage to go back to a book which one has read some time ago, and read it again, especially if it was difficult to understand on first reading.

While it is true that the field of the electrical engineer is so large that he should limit himself to special branches, yet the student who begins his studies should not specialize too soon. It will

be much better for him to get a general knowledge of the whole field first. The true specialist is one who has given special but not necessarily exclusive attention to a certain limited field, and the student ought therefore not to begin to specialize too much until after he has a very good general knowledge.

Although the number of electricians and electrical engineers is, perhaps, greater than the demand, there is, as in all other professions or vocations, "always room at the top." Those who are really interested in the subject and are willing to study need, therefore, not hesitate to enter the field even if it seems overcrowded. But to believe that there still is little known about electricity, and that this little is easily learned, is a very grave error. The student who adopts this profession should understand that it is by no means the easiest one to study, and if he does not take considerable interest in it he will make a great mistake to select it.

A few words might be added here concerning the present and future of the different branches of electrical engineering. Dynamo building has already become an exact science; to design and construct dynamos, motors and transformers which could compete with the best, requires a very large amount of study, particularly in the case of alternating current machinery. The dynamo and transformer are highly developed products and improvements in them, other than in details, will probably

be made only by the most capable engineers. In the development of accessories the field is more open. One of the most promising fields for the coming electrical engineer is in the design, erection and operation of installations. The transmission of power by electricity at present is one which offers many inducements to designing, constructing and managing engineers. Electric traction of a light order will no doubt continue its phenomenal development. The supplanting of steam by electric traction on the present steam railroads, and on new lines, is at present in the balance; but it is not unlikely that important developments may be expected, though it may be slow. Telegraphy in this country is entirely in the hands of a few large companies who do not seem to take much interest in improvements and developments, and there is therefore little encouragement to enter this field. Telephony is a field by itself in which there is open competition and therefore one in which there are opportunities. Of all the branches of electric engineering, that which is at present the youngest and least developed, and which seems to be the one in which most rapid strides can be expected, is electrochemistry. It is at the same time the one concerning which there is least known and therefore most to be learned. There is also a want of thoroughly trained electrochemists. Unfortunately, however, for the electrical engineer, this field belongs more to the chemist than to the elec-

trical engineer, as an electrochemist needs to study more about chemistry than about electricity.

Among the great and epoch making problems which are still to be solved is the direct conversion of energy as we find it into electrical energy, without the intervention of the necessarily wasteful steam engine. At present a recovery of only 20 per cent., or one-fifth, of the energy of coal, as mechanical or electrical energy, is considered good; half of this is no doubt above the average. The other problem is the economical production of light; a loss of 90 to 95 per cent. is probably less than the present average in practice. The firefly can do it; why should we not be able to find out how? These problems, however, have received the best attention of the ablest minds for years, and the student will therefore do better to leave them to those who, at least, know how it cannot be done.

Carl Hering

Helpful Hints *to the* Students *of* Electrical Engineering

by ARTHUR V. ABBOTT, C. E.

Helpful Hints *to the* Students *of* Electrical Engineering

by ARTHUR V. ABBOTT, C. E.

Mr. Arthur Vaughan Abbott was graduated from the Brooklyn Polytechnic Institute and at once entered the service of the city of New York as civil engineer. For seven years he was a member of the engineering staff of the East River bridge. He then filled several important positions as a constructing electrical engineer and in 1892 accepted his present position as chief engineer of the Chicago Telephone Company. Mr. Abbott is a prominent member of the American Institute of Electrical Engineers and is the author of *The Electrical Transmission of Energy; The Evolution of the Switchboard; History and Use of Testing Machines*, and a *Treatise on Fuel.*

The most famous living electrician, Lord Kelvin, is accredited with saying that "the best electrical engineers are good mechanics who have gained a smattering of electricity." Certainly Lord Kelvin had no intention of underrating the value to science of the researches of such profound mathematicians as Maxwell, Thompson and Heaviside, or of decrying his own matchless investigations; but he doubtless wished to emphasize the idea that the man who adapts to the advancement of civilization the discoveries of the student is worthy of equal if not greater glory. The incandescent lamp was known half a century

ago, but to Mr. Edison belongs the credit of placing it within the reach of everyone. We all revere the name of Morse as the inventor of the telegraph, but few remember that William Sturgeon was the first to make an electromagnet, on the use of which the telegraph depends. Sturgeon made a discovery of the first magnitude; Morse adapted this discovery to the betterment of human affairs. Discoveries, even in this golden age of invention, are rare; but there are few with so little inventive ingenuity as to be unable either to improve on an older process or devise a new application of some fundamental principle. It is then in this field of *adaptation* and *improvement* that the work of the electrical engineer now lies and where it seems likely chiefly to remain for an indefinite future. Sixty years ago not a dollar was invested in any electrical enterprise whatever. Today electrical industries count capital by billions. We talk across continents, and with the telegraphic cobweb we can flash a girdle round the earth in considerably less than the forty minutes required by Puck. We have harnessed the lightning; and in drawing our burdens it has not only driven the horse from our streets, but is displacing the locomotive on all but the great trunk lines. We have captured the flash, and the spark that Franklin drew from his kite string now glows in millions of lamps. Nor is the end yet, for science points

prophetically to electrical means whereby we may signal through intervening space certainly over the earth, conceivably even to other members of the solar system. But though such achievements can be wrought only by the most painstaking study and laborious investigation, a measure of success more or less great awaits all who will conscientiously devote themselves to electricity.

The first and prime requisite to success as an electrician is *mechanical ability*, the more the better; and men with this characteristic are born not made. No one would think for a moment of deliberately trying to make a Raphael or a Beethoven by education only. It is well recognized in music and painting that there must be the initial artistic spark. Training may foster and develop it, may fan it into the blaze of genius; but if the divine afflatus is missing, all the cultivation in the world can but produce a mere copyist, whether in art or engineering. Given then a mind with decided mechanical taste—for one usually does well what one enjoys—what shall be the method of education?

The ideal plan embraces a liberal college course, reinforced by the special three years' training of the technical school, to which must be added shop practice equivalent to the time served by an ordinary apprentice at the bench.

There are many, however, to whom the college and the technical school are impossibilities, as

neither the necessary time nor means are at command. But this is no ground for discouragement, as many of the brightest electricians have grown up from the ranks. Such men, for men they usually are, generally have the advantage of long shop experience and are not only good mechanics by taste and training but have gained the severe discipline of practical business life that, in addition to their trade, has inculcated thrift and shrewdness, characteristics which the college rarely recognizes. The correspondence schools afford to such an opportunity to supplement with a theoretical training of almost any desired magnitude the practical education of the bench. These schools supply a series of text-books covering courses in all branches of electrical engineering that are prepared with particular reference to the needs of those who must study at home during such hours of leisure as may be gleaned from the day of one actively engaged in a trade or profession. The student may proceed as rapidly or as slowly as desired, or may take one or more courses at pleasure. So, considering the small expense involved, the range, liberty and thoroughness secured, the busy man can hardly obtain a better method of mental training than is thus afforded, though, of course, it cannot for a moment be compared with the wider and more systematic drill of the college and technical school.

There are still other students who wish to be

architects of their educations as well as their fortunes, and to such a few words of general suggestion may be pertinent. The foundation of all engineering, and particularly the electrical branch, is mathematics; and by this is meant not simply expertness in handling *x's* and *y's* and quickly covering a page with intricate equations, but the habit of the careful examination of premises and logical reasoning therefrom that only a mathematical training can give. Sufficient arithmetical skill is always gained in the common school courses that are open to everyone; and while a knowledge of higher mathematics, such as calculus and quaternions or vectorial algebra is highly desirable, it is by no means necessary to great electrical proficiency. Algebra, geometry and plane trigonometry are necessary, and the student should read these three and exercise himself therein until the use becomes second nature.

Algebra is the language of symbols, nor is it comparable with any other science any more than music can be likened to painting. It has a tongue of its own, speaking to the student in no uncertain voice, and equipping him with a mental power that is surprising in its breadth and range. There are hosts of treatises, among which there is scarcely a selection. Loomis, Davies, Peck and Todhunter are old and tried text-books, while *Algebra Made Easy*, by Houston and Kennelly, is particularly desirable for electrical students.

Though not a work on algebra, the *Interpretation of Mathematical Formulæ*, by Houston and Kennelly, is of the greatest value. In the study of mathematics it is well for the student to read attentively, though rapidly, a number of pages without even trying to comprehend the subject completely, and then return for a careful memorization of the subject and thorough drill in examples. He may then pass to the next section, but it is of the utmost value to carefully review *all* that has preceded as each forward step is taken, for it is astonishing with what new force and with what greater clarity even the most elementary portions reappear with each review. A noted mathematician who had taught algebra for twenty years once remarked that he always learned something himself with each succeeding class. A most excellent way of reviewing is to read a variety of authors on the same subject, for in its passage through different minds new light is shed and varying emphasis laid on salient points. When it is inconvenient to be burdened with a large number of books, the various libraries will afford the reader ample opportunity for the consultation of different works.

Geometry is usually termed the science of form, but it is much more than that. It is the art of reasoning, for even logic itself is outclassed by the severe and magnificent structure of reason erected by Euclid on his five axioms, that has

withstood, unshaken, for twenty centuries all the assaults that the human mind could devise. Of all forms of mental discipline geometry is peculiar in teaching the student to examine with the utmost thoroughness the premises for his argument; to reject all that are in the least superfluous or questionable; and then to erect the logical structure slowly step by step with such compelling lucidity that the conclusions are cemented to the premises in one irrefrangible mass. Nor is the mathematical value of geometry ignored or the lessons it teaches of the relation of form slighted; of the greatest value are they and essential to future electrical study, but the broadest and highest use is the training of the reason. As in algebra there are text-books galore; but the old Playfair *Euclid* of Oxford and Cambridge, if one may procure a copy, can hardly be improved on. Todhunter, Davies, Legendre and the Harper *Euclid* are all admirable works.

Trigonometry, the last, least and easiest of the mathematical trio, is the science of angles and may be said to be a combination of both algebra and geometry, for trigonometric problems can be solved by either symbolic or Euclidian methods. It is chiefly interesting to the electrician in the investigations of alternating currents, and for this purpose sufficient acquaintance may be obtained by the expenditure of a very few days' study. Most works on geometry contain the elements of

- **ELECTRICITY**
  - **THEORY**
    - Electricity Made Easy (*Houston & Kennelly*).
    - Elementary Manual of Electricity (*Jamieson*).
    - Practical Electricity (*Ayrton*).
    - Elementary Lessons in Electricity (*S. P. Thompson*).
    - Electricity (*Larden*).
  - **PRACTICE**
    - **Construction**
      - **Lighting.**
        - Elements of Electric Lighting (*Atkinson*).
        - Electric Arc and Incandescent Lighting (*Houston & Kennelly*).
        - Electrical Engineering Leaflets (*Houston & Kennelly*).
        - Electric Light Plants (*Buckley*).
        - Electric Lighting (*Crocker*).
      - **Railroading.**
        - Electric Street Railways (*Houston & Kennelly*).
        - Electric Railway Engineering (*Trevert*).
        - American Electric Street Railways (*Hedges*).
      - **Power Transmission.**
        - Electric Transmission Handbook (*Badt*).
        - Power Transmission (*Atkinson*).
        - Power Distribution for Electric Railways (*Bell*).
        - The Electrical Transmission of Energy (*Abbott*).
      - **Telephony.**
        - Telephone Handbook (*Pool*).
        - Telephone Lines (*Hopkins*).
        - The Telephone (*Allsop*).
        - American Telephone Practice (*Miller*).
        - Manual of Telephony (*Preece & Stubbs*).
      - **Telegraphy.**
        - Electric Telegraphy (*Houston & Kennelly*).
        - American Telegraphy (*Maver*).
        - Electricity, Magnetism and the Electric Telegraph (*Lockwood*).
        - Electric Telegraph (*Herbert*).
    - **Operation**
      - **Lighting.**
        - Central Station Bookkeeping (*Foster*).
        - Electric Light and Power (*Guy*).
        - Central Electric Stations (*Nordingham*).
        - Electric Light Stations (*Killingworth*).
      - **Railroading.**
        - Tramways (*Clark*).
        - Electric Railways (*Dawson*).
        - Proceedings of the Street Railway Association.
      - **Power Transmission.**
        - No good books. See the *Electrical World* and *Transactions of A.I.E.E.*
      - **Telephony.**
        - The Telephone System of Europe (*Bennett*).
        - The Inspector and Trouble Man (*Dobbs*).
        - Back numbers of the *Telephone Magazine*.
      - **Telegraphy.**
        - Modern Telegraph Service (*Abernathy*).
        - The Quadruplex (*Maver & Davis*).

trigonometry, as for example, Playfair's *Euclid*, Davies, Legendre and the Harper *Euclid*.

The study of electricity itself may be very broadly divided into two parts, electrical theory and electrical application. The first deals with an acquaintance with the phenomena of and laws relating to that manifestation of energy that we call electricity; the second relates to the construction of machinery for the utilization thereof. While the second depends on the first, a somewhat superficial acquaintance with the profounder scientific researches may enable one to be a successful constructing or operating engineer. Electrical applications may also be divided into two parts: constructive electrical engineering, or that which deals with the design and manufacture of electrical machinery; and operative electrical engineering, relating to the management of electrical works; and further, each group may again be subdivided into electric lighting, electric railroading, power transmission, telephony and telegraphy. Schematically the preceding classification would stand as shown in the table on the opposite page. Beside each topic will be found a list of works that deal with the subject, the most elementary being placed at the top.

The preceding list is selected chiefly with reference to the first needs of electrical students. Advanced readers in electrical theory will need the works of Maxwell, J. J. Thomson, Kelvin,

Heaviside, Gerard and Hertz; in dynamo construction, S. P. Thompson, Parshall and Hobart, Weimer and Weymouth; in alternating currents, Bedell and Crehore, Steinmetz, Jackson, Fleming and Kapp; and in magnetism, Ewing, Gerard and Dubois.

To one with regular occupation the acquisition of a new science seems a formidable undertaking. So it is in one aspect. The thousand calls of home life, the natural mental inertia towards a new channel of thought, the demands of a tired body for complete and amusing relaxation are real and serious deterrents operating forcefully as barriers towards the commencement of a new line of study and as constant resistances towards progress. Conversely it is astonishing how a little will power causes these partly imaginary impediments to yield. The exercise of some resolution in rising earlier for half an hour's reading soon converts a seeming hardship into a pleasure. From the car trip to the shop or office may be daily gleaned a notable number of minutes. The time devoted to the daily paper may be most advantageously curtailed to a minimum, as it is rare that there is more than ten minutes' profitable reading in any of them. And finally, as the best rest is but a change of occupation, the student will soon realize a far keener enjoyment in a systematic course of reading than is ever secured by the novel, the theatre or the billiard ball. The knowl-

edge one acquires is valuable in proportion as it becomes an integral part of the brain. A principle tersely conveyed in a few sentences read before breakfast and held floating in the mind all day is so absorbed that it is never forgotten; it is ready for immediate use and the relation sustained to other laws rightly appreciated. The true method of study is, therefore, not the mere verbal memorization of text-book statements, but such an acquisition of the principles conveyed as will render the mind facile and nimble in their application under all circumstances.

A. V. Abbott.

SUPPLEMENTARY BOOKS

Recommended for this course by

THOMAS A. EDISON

Dynamo-Electric Machinery. By S. P. Thompson.

A very complete work liberally provided with plates. It treats of direct and alternating machinery. In places it is quite mathematical.

Electric Lighting. (2 vols.) By F. B. Crocker.

A very elaborate treatise and up-to-date. It treats of prime movers, dynamos, transformers, the lamps themselves and different systems of distribution.

Electric Transmission of Energy. By Gisbert Kapp.

An excellent work upon the theory of transmission. It says but little about existing plants. Published in 1894.

Recommended for this course by

EDWIN J. HOUSTON

The Electromagnet. By S. P. Thompson.

The theory of the electromagnet and electromagnetic mechanism is discussed. Alternating current electromagnets, electromagnets in surgery and other special forms are considered.

The Electro-Technical Series. By Houston and Kennelly.

There are ten volumes. The style is good and the method of treatment admirable. Though elementary in scope they form an excellent compend of applied electricity.

Telephone Lines and their Properties. By W. J. Hopkins.

As the name indicates this book treats not of the telephone as a system but of telephone lines—construction, induction effects and their avoidance, conduits, switchboards, etc. A book for specialists.

Twenty-Five Reading Courses

No. 1—PROBLEMS IN MODERN DEMOCRACY

Among the contributors to the handbook accompanying this course are ex-President Cleveland; Woodrow Wilson, Professor of Politics, Princeton University; Henry J. Ford, author of *Rise and Growth of American Politics;* and Henry D. Lloyd, author of *Newest England.* The books for the course are selected by Mr. Cleveland.

No. 2—MODERN MASTERS OF MUSIC

Among the contributors to the handbook accompanying this course are Reginald de Koven, Dr. W. S. B. Mathews, editor of *Music;* James G. Huneker, editor of *Musical Courier;* Henry E. Krehbiel, musical critic New York *Tribune;* and Gustave Kobbé, author of *Wagner's Life and Works.* The most attractive reading course ever offered to lovers of music.

No. 3—RAMBLINGS AMONG ART CENTRES

Among the contributors to the handbook accompanying this course are F. Hopkinson Smith, Dr. John C. Van Dyke, Dr. John La Farge, President of the Society of American Artists; Kenyon Cox and Dr. Russell Sturgis. The handbook is attractively illustrated. Mr. Smith and Dr. Van Dyke are responsible for selecting the books to be read.

No. 4—AMERICAN VACATIONS IN EUROPE

This course is the next best thing to going abroad oneself. Among the contributors to the handbook are Frank R. Stockton, Jeannette L. Gilder, editor of *The Critic;* Mrs. Schuyler Crowninshield and George Ade. The handbook has a fine portrait frontispiece.

No. 5—A STUDY OF SIX NEW ENGLAND CLASSICS

The books for this course are selected by Dr. Edward Everett Hale. Among the contributors to the handbook are Dr. Hale, Julian Hawthorne, Mrs. James T. Fields and Dr. Edward Waldo Emerson. Dr. Emerson is a son of Ralph Waldo Emerson. This is one of the most attractive courses in the entire series.

No. 6—SHAKESPEARE'S ENGLISH KINGS

The plays are selected for this course by H. Beerbohm Tree, the well-known English actor, and the books to be read in connection with the plays are selected by Sir Henry

Irving. Among the other contributors to the handbook are Prof. Edward Dowden, acknowledged the greatest Shakespearean scholar of Great Britain, Dr. Hiram Corson, of Cornell University; Dr. William J. Rolfe and Dr. Hamilton W. Mabie. The handbook is very attractively illustrated.

No. 7—CHARLES DICKENS: HIS LIFE AND WORK

Among the contributors to the delightful handbook accompanying this course are George W. Cable, the well-known novelist; Irving Bacheller, author of *Eben Holden;* Andrew Lang, the distinguished English writer; Amelia E. Barr, the novelist; and James L. Hughes, author of *Dickens as an Educator.* The books to be read are selected by Mr. Cable and Mr. Bacheller. The handbook is beautifully illustrated.

No. 8—CHILD STUDY FOR MOTHERS AND TEACHERS

Among the contributors to the handbook accompanying this course are Margaret E. Sangster, Nora Archibald Smith, Anne Emilie Poulson, Charlotte Perkins Gilman, Lucy Wheelock and Kate Gannett Wells. Mrs. Sangster selects the books to be read.

No. 9—INDUSTRIAL QUESTIONS OF THE DAY

The following distinguished writers on economic problems contribute to the handbook accompanying this course: President Jacob Gould Schurman, of Cornell University; Jeremiah Whipple Jenks, Professor of Political Science, Cornell University; Richard Theodore Ely, Director of the School of Economics, Political Science and History, University of Wisconsin; Sidney Webb, Lecturer London School of Economics and Political Science, Member London County Council; and Carroll Davidson Wright, United States Commissioner of Labor.

No. 10—FLORENCE IN ART AND LITERATURE

Among the contributors to the handbook accompanying this course are William Dean Howells, Dr. Russell Sturgis, Frank Preston Stearns, author of *Midsummer of Italian Art, Life of Tintoretto*, etc.; Dr. William Henry Goodyear, Curator Fine Arts Museum of Brooklyn Institute; and Lewis Frederick Pilcher, Professor of Art, Vassar College. The handbook has some attractive illustrations.

No. 11—STUDIES OF EUROPEAN GOVERNMENTS

The books have been selected specially for this course by the Rt. Hon. James Bryce, of the English House of Commons, and the Hon. Andrew D. White, United States Ambassador to Ger-

many. Among the other contributors to the handbook are Jesse Macy, Professor of Constitutional History and Political Science, Iowa College; and John William Burgess, Professor of Political Science and Constitutional Law, and Dean of the Faculty of Political Science, Columbia University.

No. 12—FAMOUS WOMEN OF THE RENAISSANCE

Among the contributors to the handbook accompanying this course are Col. Thomas Wentworth Higginson, Margaret Deland and Charlotte Brewster Jordan. The handbook has several very interesting illustrations.

No. 13—THE MODERN CITY AND ITS PROBLEMS

Among the contributors to the handbook accompanying this course are Dr. Frederic W. Speirs; Dr. Albert Shaw, editor of *The Review of Reviews;* Bird S. Coler, Comptroller of the City of New York, author of *Municipal Government;* and Charles J. Bonaparte, Chairman of the Executive Committee of the National Municipal League. The books are selected by Dr. Speirs.

No. 14—STUDIES IN APPLIED ELECTRICITY

This is without exception the most attractive and the most helpful reading course ever offered to students of electricity. Thomas A. Edison selects the books specially for these studies. Among the other contributors to the handbook are Dr. Edwin J. Houston, Dr. Elihu Thomson, Carl Hering, Ex-President of the American Institute of Electrical Engineers; and Arthur V. Abbott, Chief Engineer of the Chicago Telephone Company.

No. 15—FIVE WEEKS' STUDY OF ASTRONOMY

Among the contributors to the handbook accompanying this course are Charles A. Young, Professor of Astronomy, Princeton University; Sir Robert S. Ball, Professor of Astronomy, Cambridge University, and Director of Cambridge Observatory, England; Camille Flammarion, founder of the Astronomical Society of France, and author of *Marvels of the Heavens, Astronomy, etc.;* George C. Comstock, Director of Washburn Observatory, University of Wisconsin; and Harold Jacoby, Professor of Astronomy, Columbia University. The study programme includes contributions from the most famous astronomers of England and France.

No. 16—RECENT ENGLISH DRAMATISTS

Lovers of the best modern dramas will find much pleasure in these studies. Among the contributors to the handbook are Brander Matthews, Professor of Literature, Columbia University;

Dr. William Winter, Dramatic Critic for the New York *Tribune;* Dr. Harry Thurston Peck, Editor of *The Bookman;* Louise Chandler Moulton; and Norman Hapgood, the well-known writer of dramatic criticism. The handbook has some interesting illustrations.

No. 17—STUDIES IN CURRENT RELIGIOUS THOUGHT

The books are chosen for the course by Dr. Lyman Abbott and Dr. Washington Gladden. Among the contributors to the handbook are Dr. Samuel D. McConnell, Rector of Holy Trinity Church, Brooklyn; President William DeWitt Hyde, of Bowdoin College; Dr. Amory H. Bradford, Editor of *The Outlook;* Dr. Henry Collin Minton, of San Francisco Theological Seminary, late Moderator of the Presbyterian General Assembly; Dr. H. W. Thomas, Pastor of the People's Church, Chicago; and Dr. Theodore T. Munger, Pastor of the United Congregational Church, New Haven. For clergymen and laymen who wish to stimulate the growth of a theology which is in harmony with the best thought of the time we recommend this handbook and this reading course.

No. 18—THE GREATER VICTORIAN POETS

The books are selected for this course by Thomas Bailey Aldrich. Among the other contributors to the handbook are Thomas R. Lounsbury, Professor of English, Yale University; Dr. T. M. Parrott, of Princeton University; and Marie Ada Molineux, author of *The Phrase Book of Browning.*

No. 19—OUT-OF-DOOR AMERICANS

Among the contributors to the handbook accompanying this course are John Burroughs, Ernest Seton-Thompson, President David Starr Jordan, of the Leland Stanford Junior University; Ernest Ingersoll and Hamlin Garland. Lovers of nature will find delight in the outlines and recommendations of this course.

No. 20—THE WORLD'S GREAT WOMAN NOVELISTS

Mrs. Humphry Ward, the well-known English novelist, is the first contributor to the handbook accompanying this course. The other contributors are Elizabeth Stuart Phelps Ward, Mary E. Wilkins, Agnes Repplier, Katherine Lee Bates, Professor of English, Wellesley College; and Oscar Fay Adams. The handbook contains some interesting illustrations.

No. 21—AMERICAN FOUNDATION HISTORY

Hon. Henry Cabot Lodge selects the books for this course. Among the other contributors are Albert Bushnell Hart, Professor of American History, Harvard University; John Bach

McMaster, Professor of American History, University of Pennsylvania; Reuben Gold Thwaites, Secretary of the State Historical Society of Wisconsin, author of *The Colonies;* Paul Leicester Ford, author of *Janice Meredith;* and Andrew Cunningham McLaughlin, Professor of American History, University of Michigan.

No. 22—STUDIES IN AMERICAN LITERARY LIFE

Professor Barrett Wendell and Professor Lewis E. Gates, of Harvard, and Dr. Horace E. Scudder, late editor of *The Atlantic Monthly*, contribute to the handbook accompanying this course. For a brief stimulative and instructive course in American literature nothing better could possibly be offered.

No. 23—STUDIES IN RECENT FRENCH FICTION

Alcée Fortier, Professor of Romance Languages, Tulane University of Louisiana, has chosen the books for this reading course. Among the contributors to the handbook are the three distinguished French writers, Edouard Rod, Ferdinand Brunetière and Paul Bourget, and the notable American critic, Dr. Benjamin W. Wells, author of *Modern French Literature* and *A Century of French Literature.*

No. 24—THE ENGLISH BIBLE: HOW WE GOT IT

The contributors to this course include President William R. Harper, of the University of Chicago; John Franklin Genung, Professor of Rhetoric, Amherst College; William Newton Clarke, Professor of Christian Theology, Colgate University; and Richard G. Moulton, Professor of English Literature, University of Chicago. The handbook is a very interesting and instructive volume in itself.

No. 25—THE MECHANISM OF PRESENT DAY COMMERCE

In Preparation. The books are selected by the Hon. Lyman J. Gage, Secretary of the Treasury.